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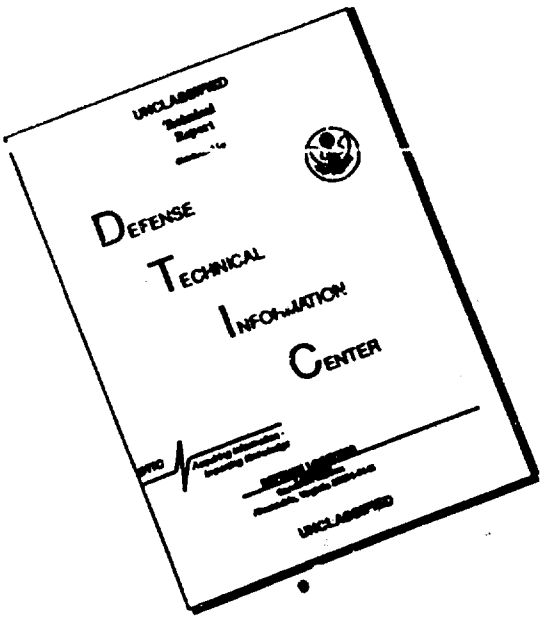

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THE CRITERIA OF TAXONOMIC CATEGORIES

- USSR -

[Following is the translation of an article by B. A. Vaynshteyn, Institute of Reservoir Biology of the Academy of Sciences USSR (Borok, Nakouzskiy Rayon, Yaroslavskaya Oblast'), in the Russian-language publication Zoologicheskiy Zhurnal (Zoological Journal), Vol XXXIX, No 12, Moscow, 1960, pages 1774-1778.]

(The article is presented by way of discussion.)

In recent years two articles have been published in the Zoologicheskiy Zhurnal, in which the problem of the criteria of taxonomic categories has been dealt with. The author of the first of these -- O. L. Kryzhanovskiy (1954) -- discussing the objective criteria of a genus, finds them to lie within the community of origin, morphology, and biology of all species subsumed under the genus. In the second article (Rubtsov, 1959) the uniformity of including features of the subimago phases of growth to explain species differences and subsequently presents the concept that reproductive isolation serves as the best feature in solving the problem of the independence of a given species.

The studies referred to stimulated the author to briefly state his own view on the criteria of taxonomic categories. To reduce the length of the article a literature survey is not given and as far as possible related problems of theoretical systematics are circumvented.

The natural system of living organisms is a hierarchical system. This means that each higher taxonomic unit consists of a group of lower taxonomic units, joined by a commonness of certain characteristics. The existence of such a system is based on the differentiation of characteristics.

As characteristics we designate any properties and any features of the organism which can be used in systematics. Of course, each organism can be found to have an unlimited number of properties, but not all are suitable and accessible to systematic study. The most convenient and, therefore, the most often used are the morphological features. Without discussing here the correctness of such a preference, we wish only to emphasize that we regard characteristics

as being not only the morphological features of the organism, but any others, although we assume that the morphological characteristics will be wholly adequate to establish a natural system; nonetheless characteristics that are biological, physiological, ecological, etiological, geographical, and others are always associated with morphological characteristics, as a function is bound up with form.

Differentiation of features consists in their infinite devisibility and detailing. Each feature (characteristic, property) serves as a partial manifestation of a more general property of the organism or of its parts, organs, and structures, and determines other numerous, though less complicated, properties and features. And these latter, in their turn, other still more simple properties. And so on ad infinitum. Such an order of interdependence of characteristics led A. A. Lyubishchev (1923) to speak of their hierarchy. Actually, this system of characteristics of the organism exhibits to a greater extent hierarchiality. Thus, for example, the characteristics of the extremity of an arthropod is determined by the features of its component segments (their number, form, and arrangement); the features of the segments -- by the characteristics of their constituent sclerites and internal structures; the sclerites, in their turn, exhibit the characteristics of form, color, and extensibility; extensibility is characterised by number, size, form, and color of the fibers, etc.

However, between the system of characteristics and the system of organisms there are substantial differences. In the system of any group of organisms it is wholly conceivable to drop several of the cosubordinated groups or to discover new groups. Such changes are not reflected in the system of the group as a whole. The discovery of the okapi, and the general disappearance of Przheval'skiy's horse or the culan /Asinus hemionus/ did not change the general system of non-artiodactyla animals. On the contrary, the omission of one of the characteristics of an organism is wholly inconceivable. It is possible, of course, for a given organ to be absent, but the absence of an organ is also a characteristic. However, the existing organ cannot be deprived of a single of its characteristics. Each of the hairs of the chaetomiun /khetom/ can exhibit only the characteristics proper to itself: form, position, color, size, etc., but a hair without form or without position, color, size, etc., is impossible.

A second distinction in the system of characteristics from the system of organisms is found in infinite divisibility, detailing of characteristics, and the absence of ultimate and elementary characteristics, whereas at the same time the elementary object of the system of organisms is species.

Finally, the last distinction between the system of characteristics and the system of organisms is the following: it is generally believed, and this is true enough, that the system of organisms from beginning to end is hierarchical. A certain element

of combinativeness is marked only in the lower taxonomic categories. But in the hypothetical system of characteristics (in practice it has not yet been formed) combinativeness must play an essential role. The system of characteristics, strictly speaking, must be a hierarchic-c[illegible]ntive one.

Therefore, it would be more correct to speak not of a hierarchy of characteristics, which is not always strictly maintained, but of their differentiations and integration.

The same characteristic can be differentiated differently in two neighboring taxonomic groups, and vice versa: in the same group different characteristics vary differently. However, if there is not a single hierarchy of all the characteristics, then in one of the systematic groups there is observed its own, more or less strictly maintained, hierarchic-combinative differentiation of characteristics. Such a differentiation results in a hierarchy of the natural system, reflecting the kindred relationships existing in nature among the organisms. Let us examine, as an example, the differentiation of the characteristics of the construction of the empodium for several arachnoidal mites (Tetranychidae): 1) the empodium is or is not present; 2) with or without hairs; 3) hairs on the top or on the bottom of the empodium; 4) the number of top hairs are even or odd; 5) the relative dimensions of the distal and the proximal pairs of hairs, etc..

Descending this ladder of thought, we move from the subfamily to the species. The characteristics of the higher category characterized the taxonomic groups of the higher rank, and the characteristics of the lower category -- the lower rank.

Comparing between each other two groups of the same taxonomic rank (for example, two families), it is easy to note that the nature of the variability of the characteristics in these groups is frequently different, in which even the range of variability and the number of degrees in the gradation of characteristics -- the "width" and "depth" of variability -- can also be differentiated. In the first case, the number of taxonomic groups of the same rank (for example, genera) vary, in the second case, a different number of co-subordinated degrees (subfamilies, tribes, subtribes, subgenera, etc.) arise. Let us examine, as an example, two families of the superfamily Tetranychoidea. The family of flat-bodied mites (Tenuipalpidae) consists of 14 genera, containing about 150 species. These genera are not broken down into subgenera and are not joined in tribes and subfamilies, which explains the insignificant extent of gradation of characteristics of the constituent species. The family of arachnoidal mites (Tetranychidae) are broken down into three subfamilies, two of which in their turn are divided into tribes; of 24 genera of the family seven are broken down into subgenera; the total number of species of the family is about 250. In this way, there are no other taxonomic categories in the family Tenuipalpidae except for genera (and species, of course), but in the family Tetranychidae there are, in addition, subfamilies, tribes,

and subgenera. Such a difference can be partially explained by the different study approach to these families, but basically it stems from the different nature of variability of the characteristics in these families; in the arachnoidal mites the peritremes can exist with a funnel-shaped opening [rastrub] or without such, the peritremes may be simple or branched, for the flat-bodied mites they are always simple, without a funnel-shaped opening; the empodium for the former can have chaetoids or not, with hairs or without, or either the empodium can be entirely absent, for the flat mites the empodium is always present and always has chetoids, without spines; the sensilla on the legs of the arachnoidal mites can be setiformed or arcuate, armed with tactile chaeta or not so supplied, the flat mites never form chaeta pairs, they are always thickened and blunted, of the "epatid" [?] type, etc. In this way, the nature of the variability of the characteristics determines, on the one hand, the number of degrees in the hierarchy of the system and, consequently, the different number of taxonomic categories within individual groups, and, on the other hand, the number of groups in the same category.

However, it must be mentioned that using expressions like "the characteristics determine the system," "the system stems from the characteristics," etc., we will never keep in mind that the system is created by the characteristics. The system of organisms exists in nature independent of the considerations of systematicists, but these considerations are built from a study of characteristics, which, as was said above, serve only as individual manifestations of the qualitative features of the organisms.

From the foregoing it must be clear that not a single individually examined characteristic (or system of characteristics) can serve as a universal criterion to solve the problem of the rank of taxonomic groups, for each of these serves only as a degree in a general unending differentiated series of characteristics.

The genus criteria suggested by O. L. Kryzhanovskiy -- the community of biology, etc. -- have been of little success: species belonging to a single genus do not exhibit the same biology, to some extent it is always different; on the other hand, not only do the genera but also the higher taxonomic groups exhibit a definite commonness of biology. It is enough to point to such commonplace examples as the relationship of all fish to water or of most birds to flight. Each biologist in any systematic group can easily form a hierarchical system, based only on biological characteristics and can be convinced of the unsuitability of biological characteristics as criteria of any taxonomic category, including also the category of genus.

The same can be said of both the morphological and the phylogenetic criteria. The suggestion of O. L. Kryzhanovskiy, that the genus is characterized by commonness of origin, biology, and morphology of the species subsumed therein is, of course, correct, but this cannot serve as a criterion for the genus since it is applicable in equal measure to all taxonomic categories.

We find a somewhat better situation when we are dealing with reproductive isolation. This characteristic has been frequently put forth as a species criterion. However, it is not always suitable for such a purpose. Of course, the range of its variability is less than for other characteristics, but the variability itself undoubtedly exists. The numerous species and even inter-genus hybrids are well known, as is the sterility of several intra-species interbreedings (cf for example, Astraurov, 1955-56), and it is known that the fertility in crossbreedings of various intra-species forms and of species can vary within broad limits. In other words, the characteristic of fertility in the crossbreeding of doubtful forms varies quite broadly and, therefore, cannot serve as universal species criterion. In this connection, we cannot even speak of the forms of falcultatively or obligately parthenogenetic forms.

However, an objective criterion for the species exists and consists of the existence of a continual variability within the species and in the absence of such variability (the existence of a hiatus) among individual species. In distinction to higher taxonomic categories, the species is the smallest group, separated by a hiatus, but in distinction to the lower taxonomic categories -- is the highest category with continuous variability. Or, as Ye. S. Smirnov (1959) states, ". . . the species is a continuum of individuals." If to this is added, "the largest continuum," or "a complete continuum," and in this way the concept of species and subspecies are delineated, then the definition presented can be found wholly satisfactory. Not delving into the problems of intra-species variability, we only point to the fact that the system of lower taxonomic categories proposed by A. P. Semenov-Tyan-Shansk (1910), and improved by B. S. Kuzin (1951), appears to us entirely objective, and the criteria suggested by the authors for lower taxonomic categories are suitable.

There are no objective criteria for the higher taxonomic categories. Studying the similar relationships of a group of species, we can by way of example establish that they form such a system: group A consists of several, groups of B differing identically among each other (B_1, B_2, B_3 . . .), each of which contains several species. We will assume that the similar relationships discovered by us are objective, that is, they correspond completely to the similar relationships between the given species in nature. However, a correct determination of systematic interrelationships among the groups does not afford sufficient grounds to determine their taxonomic ranks. Actually, how are the groups A and B regarded? As genus and subgenera? Or as family and genera? Or in some other fashion? Frequently a researcher, carrying out a revision of a group, and convinced of its greater complexity than has previously appeared to be the case, without thinking elevates the entire group studied to a higher taxonomic rank. A clear example of such work is the article of Z. Feyder (1959), who converted the superfamily of Trombiculid mite /kleshch-krasnotelka/ into a phalanx, at the same time

raising the families of this group to superfamilies, and the subfamilies to families. Of course, such a variety of "revision" yields little to science. Without refining the actual interrelationships among the groups of organisms, they only entangle matters, constantly changing the ranks of groups and not harmonizing these changes with the neighboring groups. Actually, if one group, in the given instance of the superfamily Trombidoidea, is suddenly changed into a phalanx, then how will all the other remaining subfamilies of the suborder now be regarded? Also as phalanxes? Or are the differences among the subgroups of the Trombiculids greater than in the neighboring superfamilies? But if the latter is true, then it is precisely this that must be shown, raising the group to a new rank. Meanwhile the author has also not mentioned the neighboring superfamilies, and all his research is limited to the Trombiculids. There are many such examples.

It appears to us that in the "Rules of Zoological Nomenclature" it must be urgently recommended that a change in the rank of any taxonomic category be carried out only upon the revision of the group in the higher taxonomic rank. To elevate a genus to a tribe is possible only by revising the subfamily or family, but to elevate a subfamily to a family can be done when revising a group not lower than a superfamily. A change in the rank of the group being revised must be forbidden.

Resuming the foregoing and returning to the problem posed at the beginning of the article, it must be said that the establishment of the taxonomic rank of a group must be done on three criteria: 1) objective criterion of the species; 2) the existing rank of the group revised, which must not change in any case; and 3) a rational use of taxonomic categories intermediate between species and higher category of the group being studied. In the latter, of course, there is a subjective element introduced, which, however, is neutralized to a considerable extent by comparison with the nearest groups and, of main importance, by the proposed restriction in the selection of the rank of the entire group as a whole.

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